MODIS True Color Images in Real-Time over the United States via the Web and Google Earth

Liam Gumley, Amato Evan, Bill Bellon, Kathy Strabala, and Jerry Robaidek.

Space Science and Engineering Center,
University of Wisconsin-Madison.

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Presentation Outline

1. Overview of Direct Broadcast activities at SSEC
2. Direct Broadcast Processing System at SSEC
3. “MODIS Today” Images for the Web and Google Earth
4. Examples of MODIS images in Google Earth

Direct Broadcast Reception Facility at SSEC

SeaSpace 4.4 meter antenna; operational since Jan. 2001.

Receives Terra and Aqua routinely (can receive, Oceansat, ERS-2, Radarsat).

Direct Broadcast Activities at SSEC

Objectives

1. Routine acquisition and processing of direct broadcast data.
2. Creation of real-time products for operational customers.
3. Development and distribution of DB processing software.

Accomplishments

- Have acquired more than 20,000 Terra and Aqua passes.
- MODIS, AIRS, and AMSR-E products are created automatically and made available to the public via FTP and the Web.
- IMAPP MODIS/AIRS/AMSR-E software now in use on every continent (credit: MODIS and AIRS Science Teams)
- Active member of IPOPP Team with NOAA IPO and NASA DRL

Funding

NASA HQ, NOAA IPO

Major Customers for SSEC Real-time Direct Broadcast Data

National Weather Service

Imagery for Forecasters

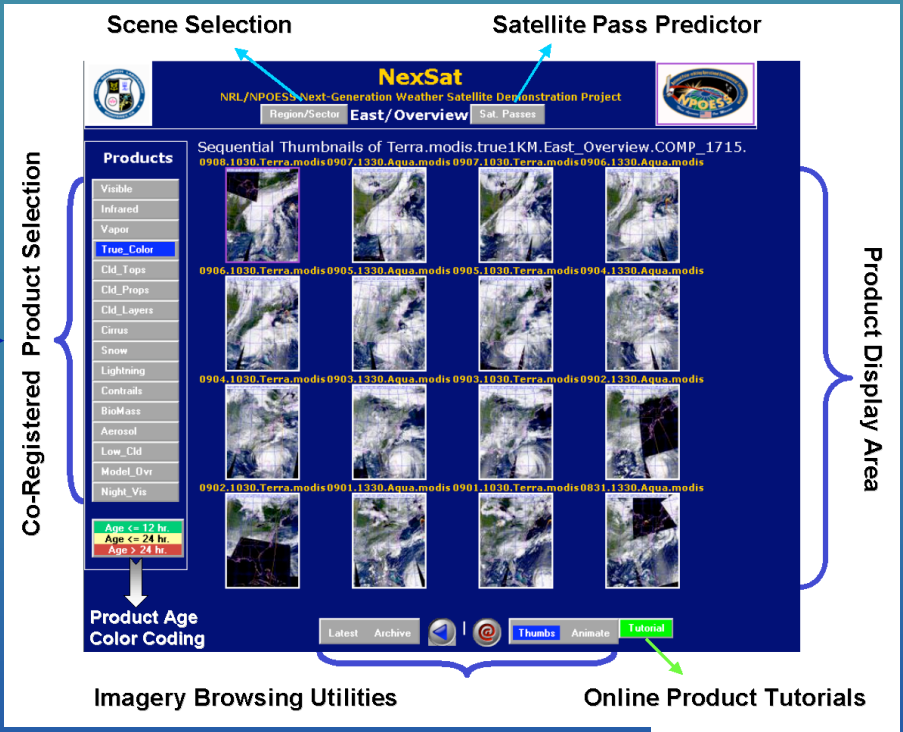
NRL Monterey

NexSat Website

Product Development

Canadian Ice Service

Ice Analyses



NOAA Great Lakes Environmental Research Lab

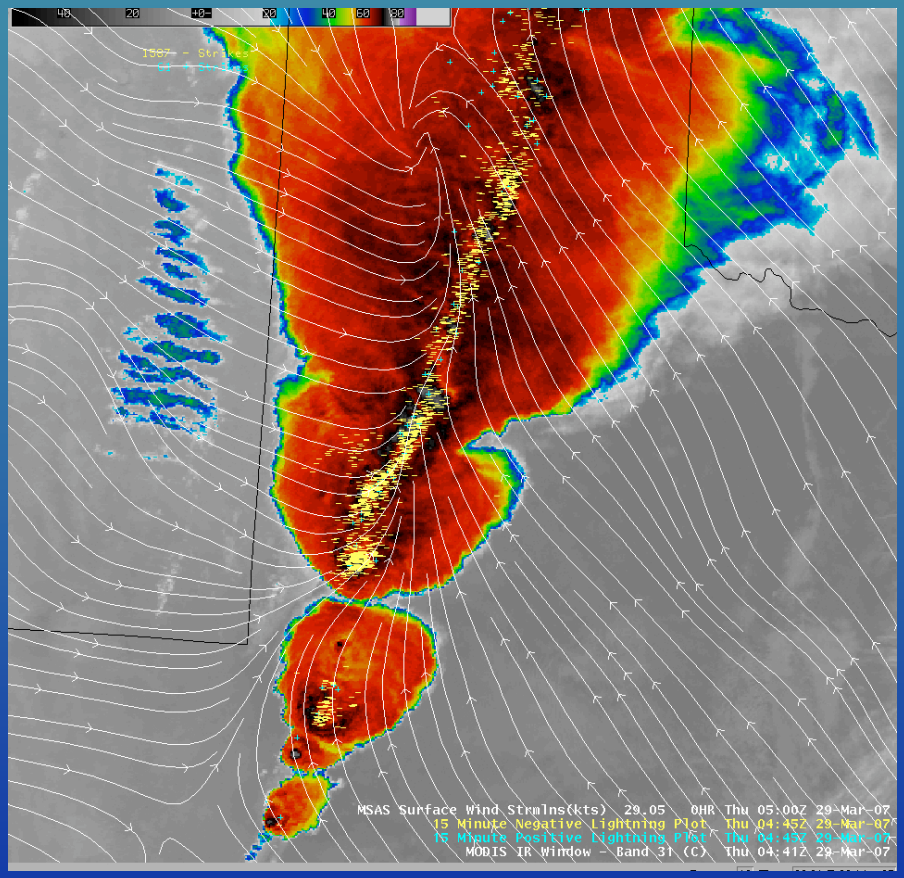
JPEG and GeoTIFF images for Great Lakes

NASA/Environmental Protection Agency IDEA Project

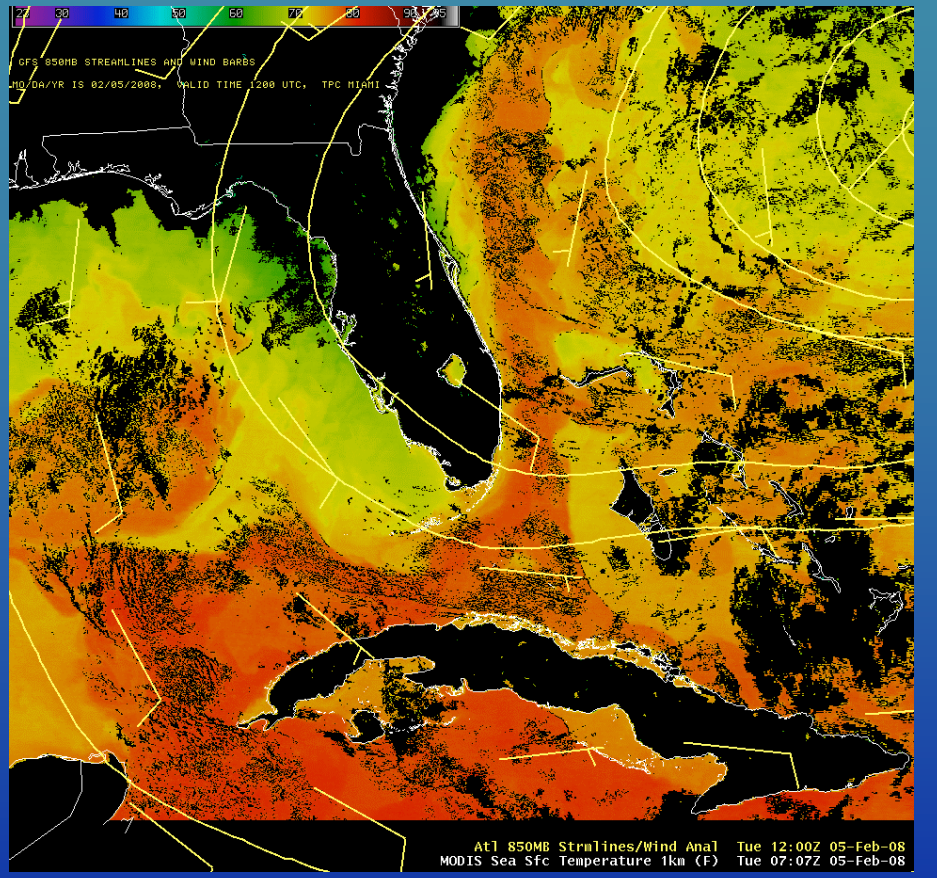
L1B data and images for air quality forecasts

National Weather Service

MODIS IR Window BT



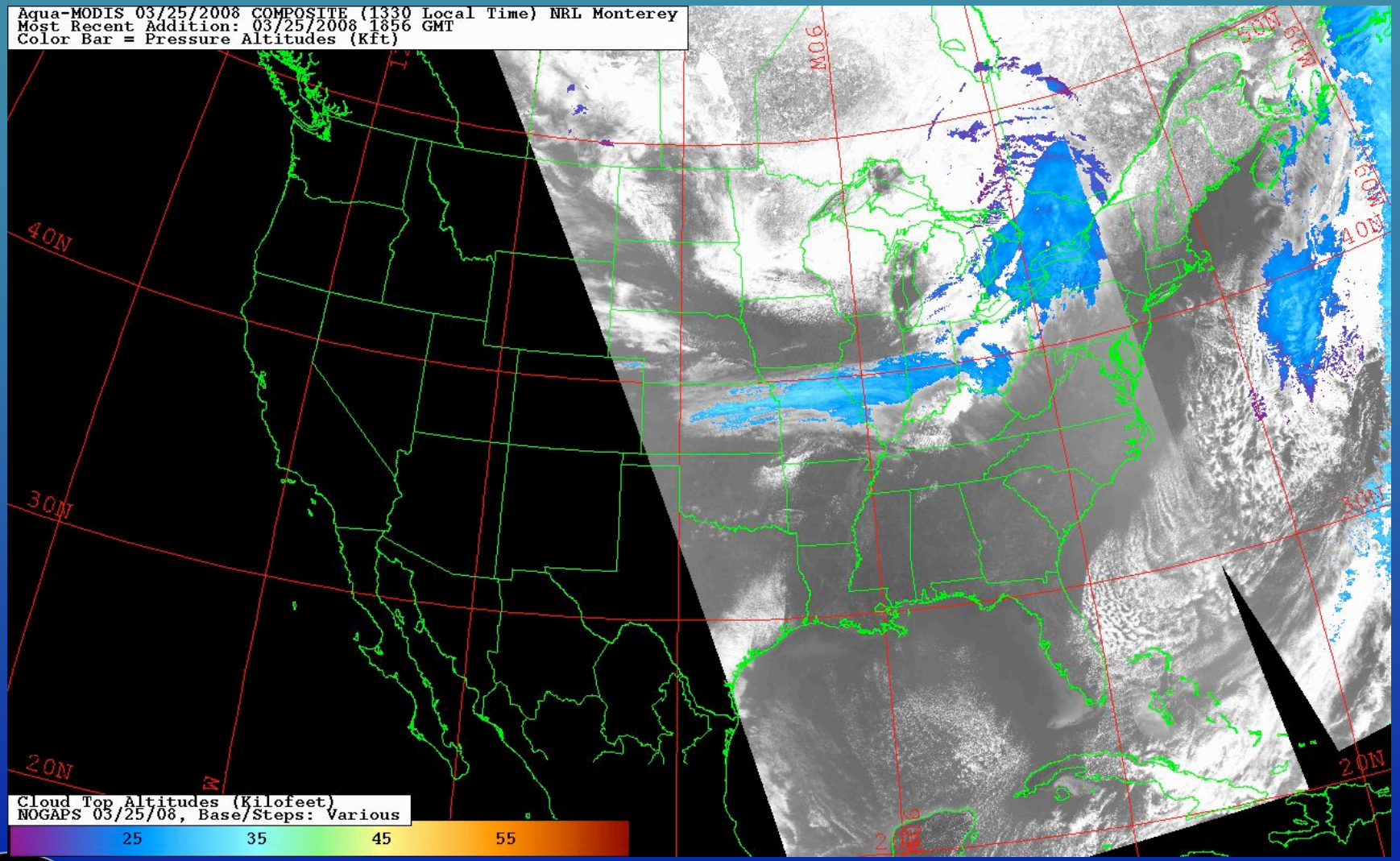
MODIS SST



Both displayed in AWIPS

Naval Research Laboratory, Monterey

MODIS Cloud Top Height

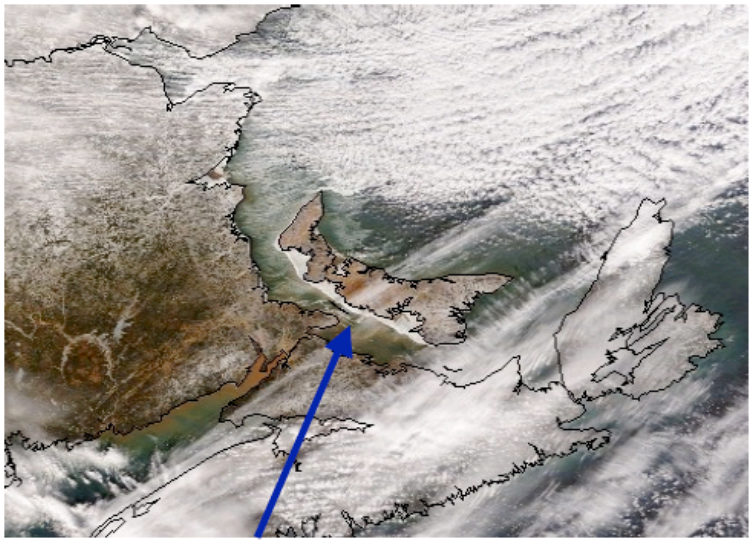


Canadian Ice Service integrates MODIS into operational data stream for ice monitoring

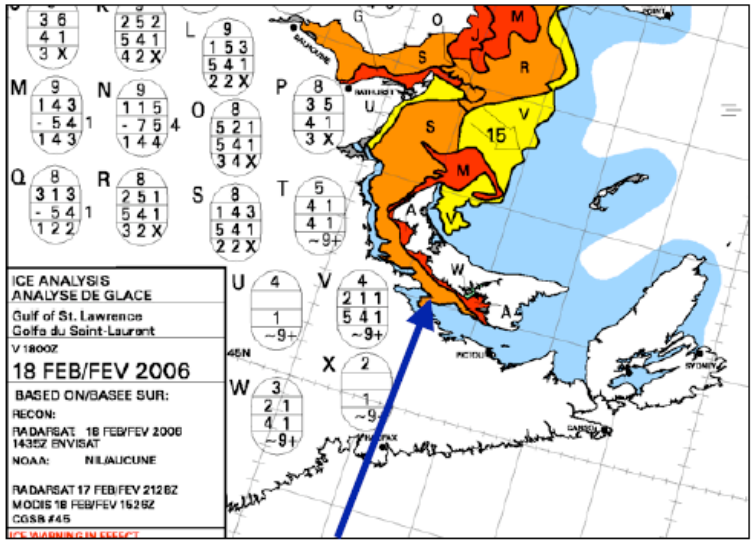
CIS data suite includes RadarSat and Envisat (SAR); AMSR, QuikScat and SSM/I (microwave); MODIS, OLS, NOAA and GOES (visible images).

- MODIS supplements SAR data in clear sky conditions.
- 250 meter resolution true color GeoTIFF images are obtained daily from SSEC for Great Lakes, Hudson Bay, Labrador coast, and Gulf of St. Lawrence.

MODIS helps to define ice boundary along southern Prince Edward Island



MODIS DB image 2006/02/18 15:26 UTC



CIS Ice Analysis 2006/02/18

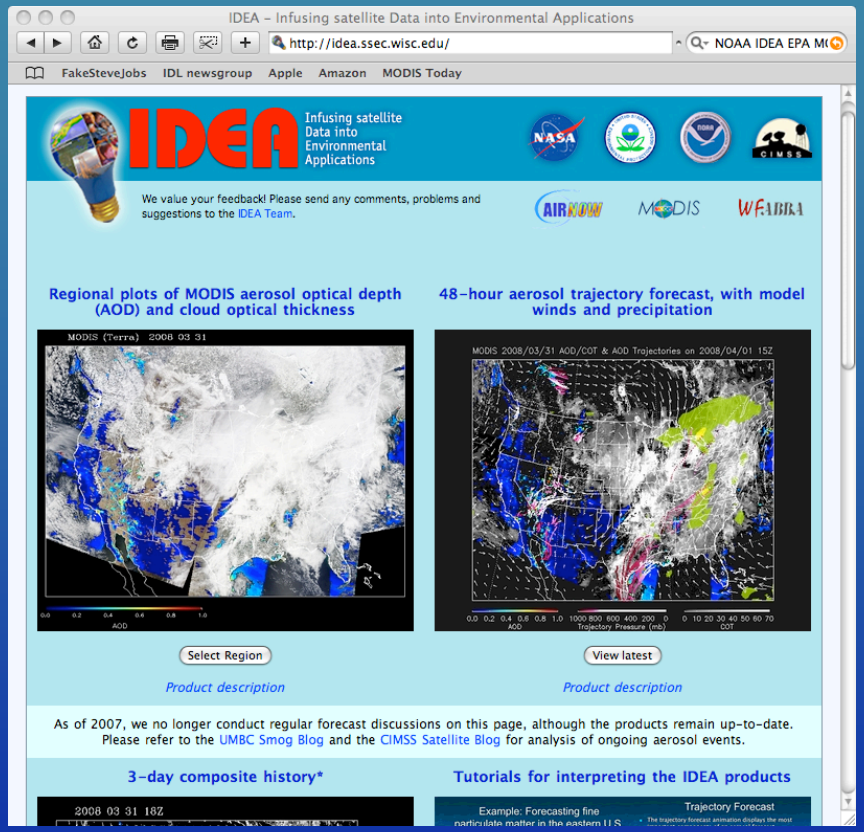
NOAA CoastWatch

CoastWatch Website

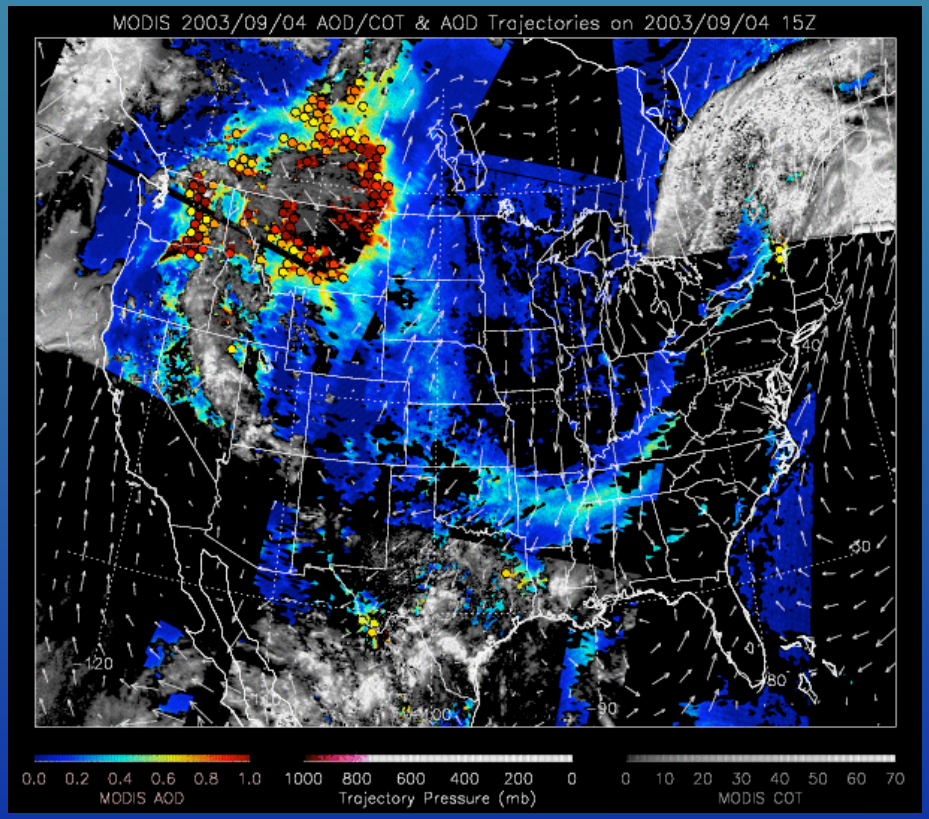
Lake Huron / Georgian Bay

IDEA Website (NASA & Environmental Protection Agency)

IDEA Website



Trajectory overlay on MODIS Aerosol Optical Depth



International MODIS/AIRS Processing Package (IMAPP)

Builds upon our previous experience with
- ITPP (International TOVS Processing Package) since 1985
- IAPP (International ATOVS Processing Package) since 1998

Purpose:
- The intention in developing IMAPP for processing direct broadcast MODIS, AIRS, AMSU, AMSR-E data is to help foster the rapid improvement of retrieval algorithms and other applications of EOS data in a variety of global weather, process studies, and climate applications, just as the ITPP and IAPP have done for TOVS and ATOVS data.

Available from:

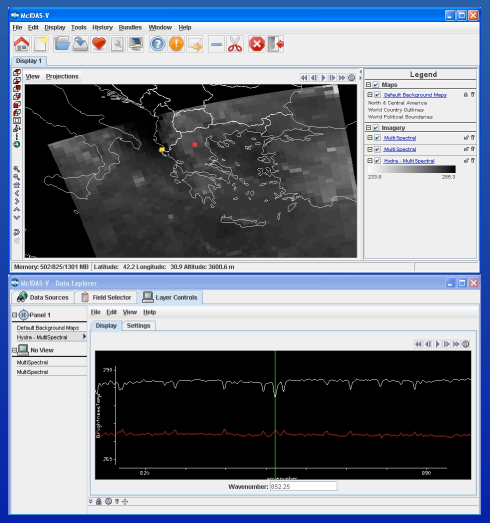
http://cimss.ssec.wisc.edu/imapp/

International Polar Orbiter Processing Package (IPOPP)

SSEC IPOPP Tasks

1. Adapt VIIRS Atmosphere EDRs to run on Linux in Direct Broadcast mode
2. Adapt CrIS/ATMS RDR, SDR, EDRs to run on Linux in Direct Broadcast mode
3. Visualization of SDR and EDRs (VIIRS, CrIS, ATMS)
4. Training and Education

AIRS in McIDAS-V



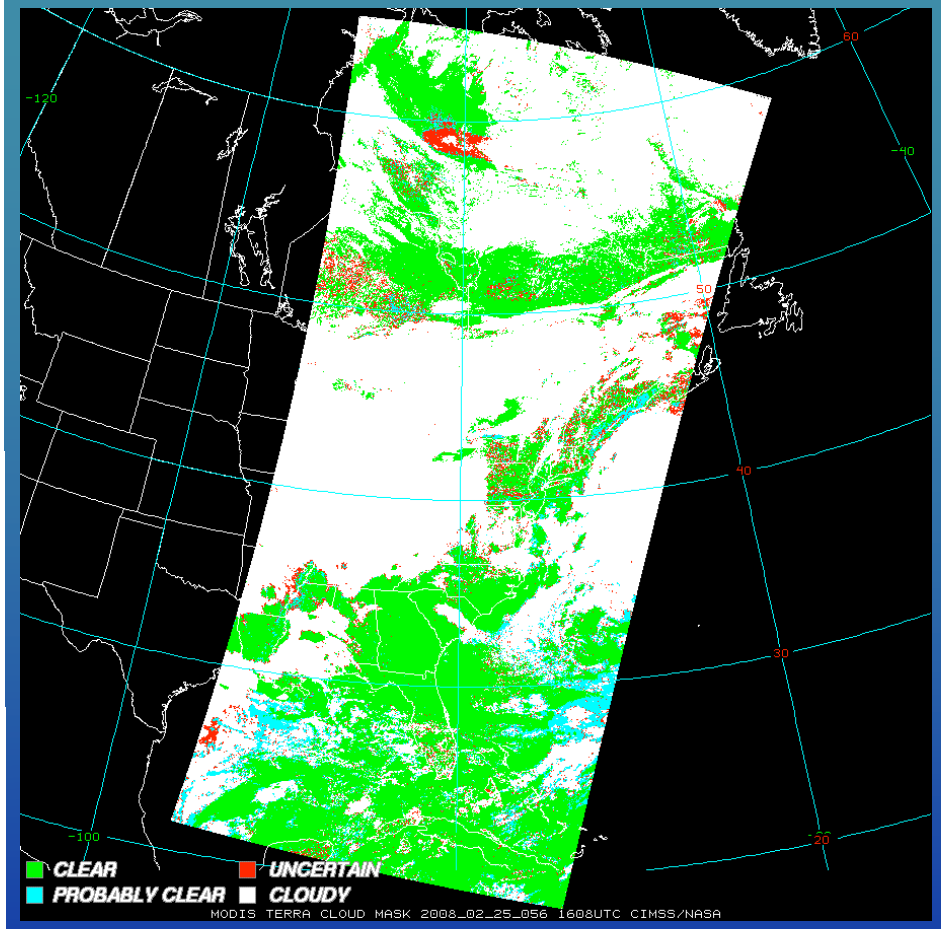
MODIS/AIRS Workshop
Pretoria, South Africa

Strategy for porting VIIRS Atmosphere EDRs to Linux

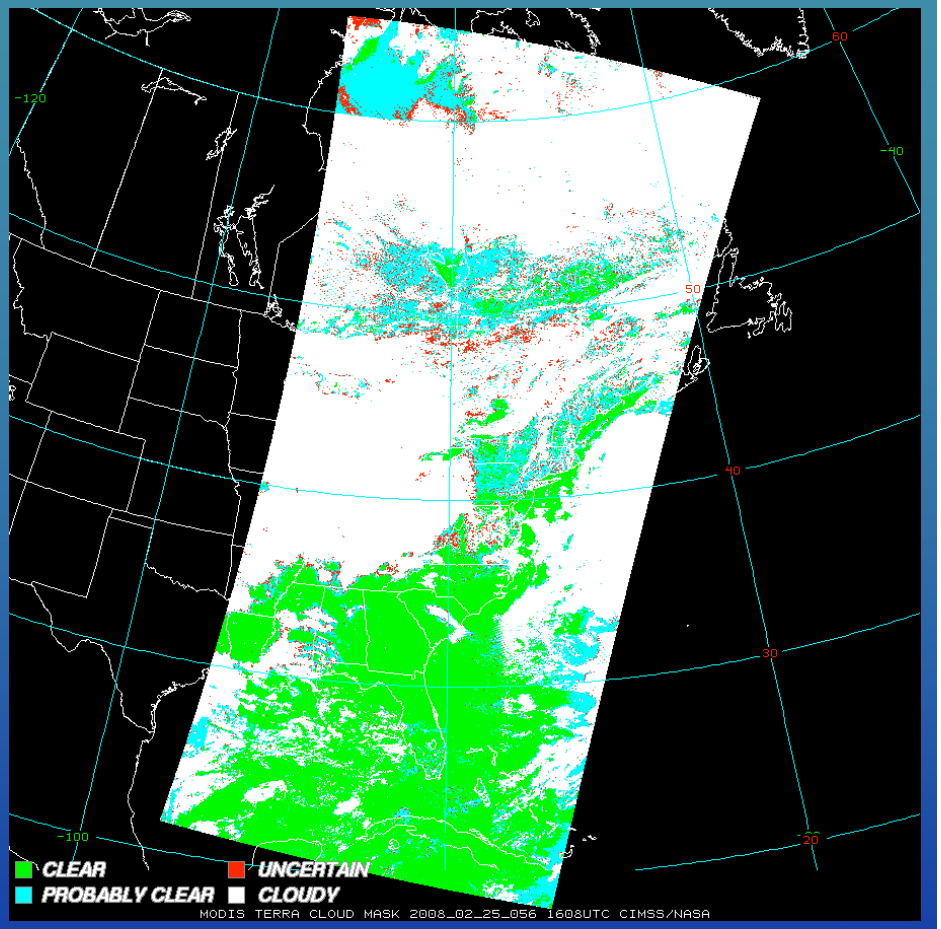
Low Earth Orbit Cloud Algorithm Testbed (LEOCAT)

- Developed by Mike Pavolonis (NOAA/UW)
- Provides an I/O framework for ingesting image sensor data (AVHRR, MODIS, VIIRS) and ancillary data (e.g., NCEP, ECMWF)
- Science algorithms are encapsulated within I/O framework via a wrapper interface

LEOCAT is now running in real time Direct Broadcast mode



MODIS C5 Cloud Mask
2008/02/25 1610 UTC (Terra)



VIIRS OPS 1.4 Cloud Mask
2008/02/25 1610 UTC (Terra)

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SSEC DB Processing System Requirements

Reliable: Products must be generated 24x7x365

Consistent: Products must be available with the same format, name, content and location every day

Timely: Products must be available as soon as possible following acquisition

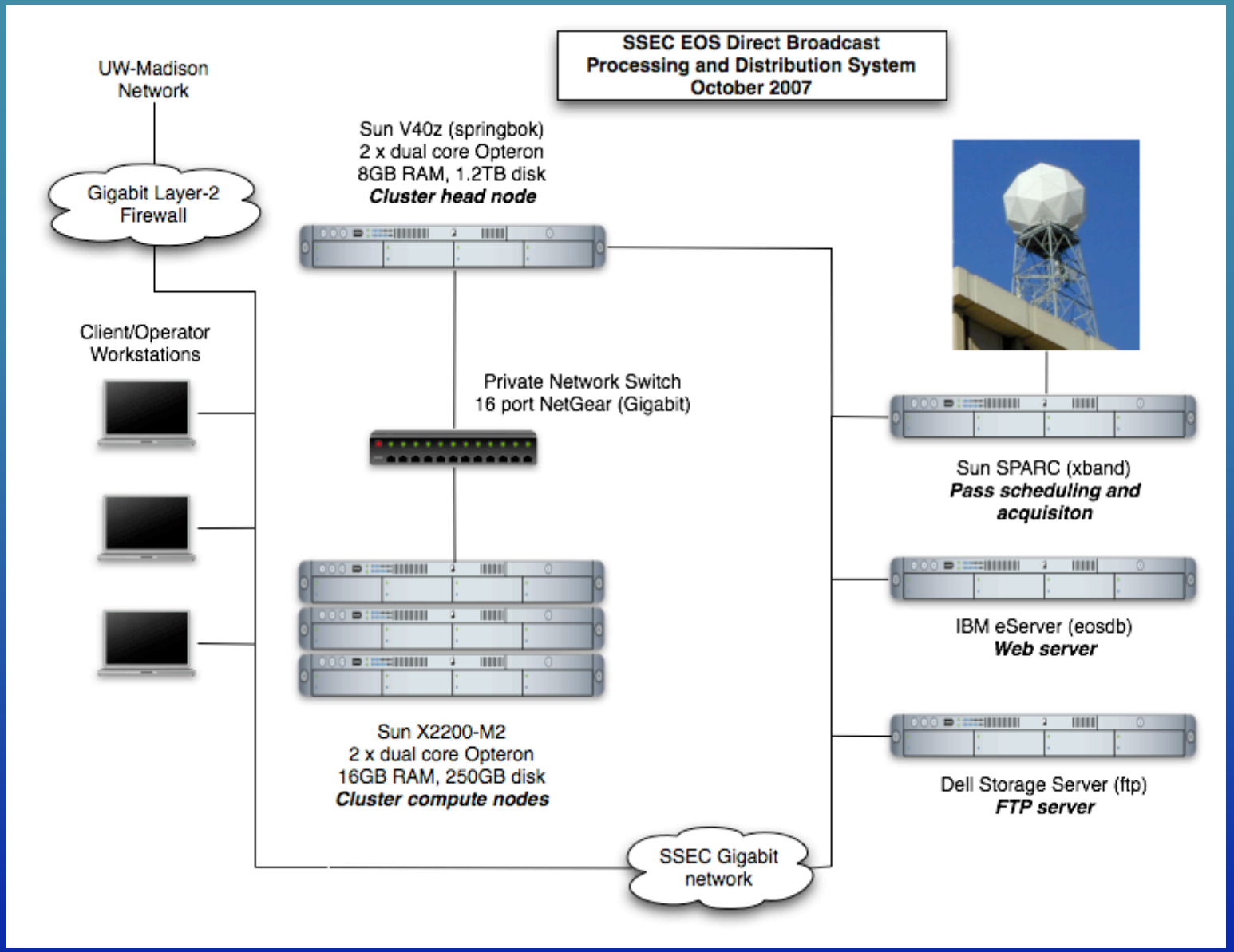
System as implemented is

(1) Maintainable by operators and developers (not a black box)

(2) Based on commodity hardware and freely available software

(3) Capable of reprocessing on demand

SSEC DB Processing System: Schematic



SSEC DB Processing System: Key Technology Decisions

Linux Cluster (distributed or single system)

- Uses commonly available hardware (Sun servers with AMD Opteron CPUs, SATA disks, Gigabit Ethernet)
- Open source Linux cluster distribution (Rocks)
- Can be implemented on single system with multiple CPUs (system ported to dual quad core desktop box)

Sun Grid Engine (open source job manager)

- SGE provides a simple command line interface for submitting and managing a list of jobs. Scales from a few jobs to thousands (FIFO job scheduling).

Bash and C shell scripting languages

- Operators and developers know Bash and C shells
- Helps ensure maintainability of the system

Software Components

NASA DRL/MODIS Science Team: RT-STPS, GBAD, MOD14, MODLST, NDVI/EVI, CREFL, MOD09 (C5)

University of Dundee: EOSLZX

NASA Ocean Biology Processing Group: MODISL1DB, SeaDAS

USGS: MRTSwath

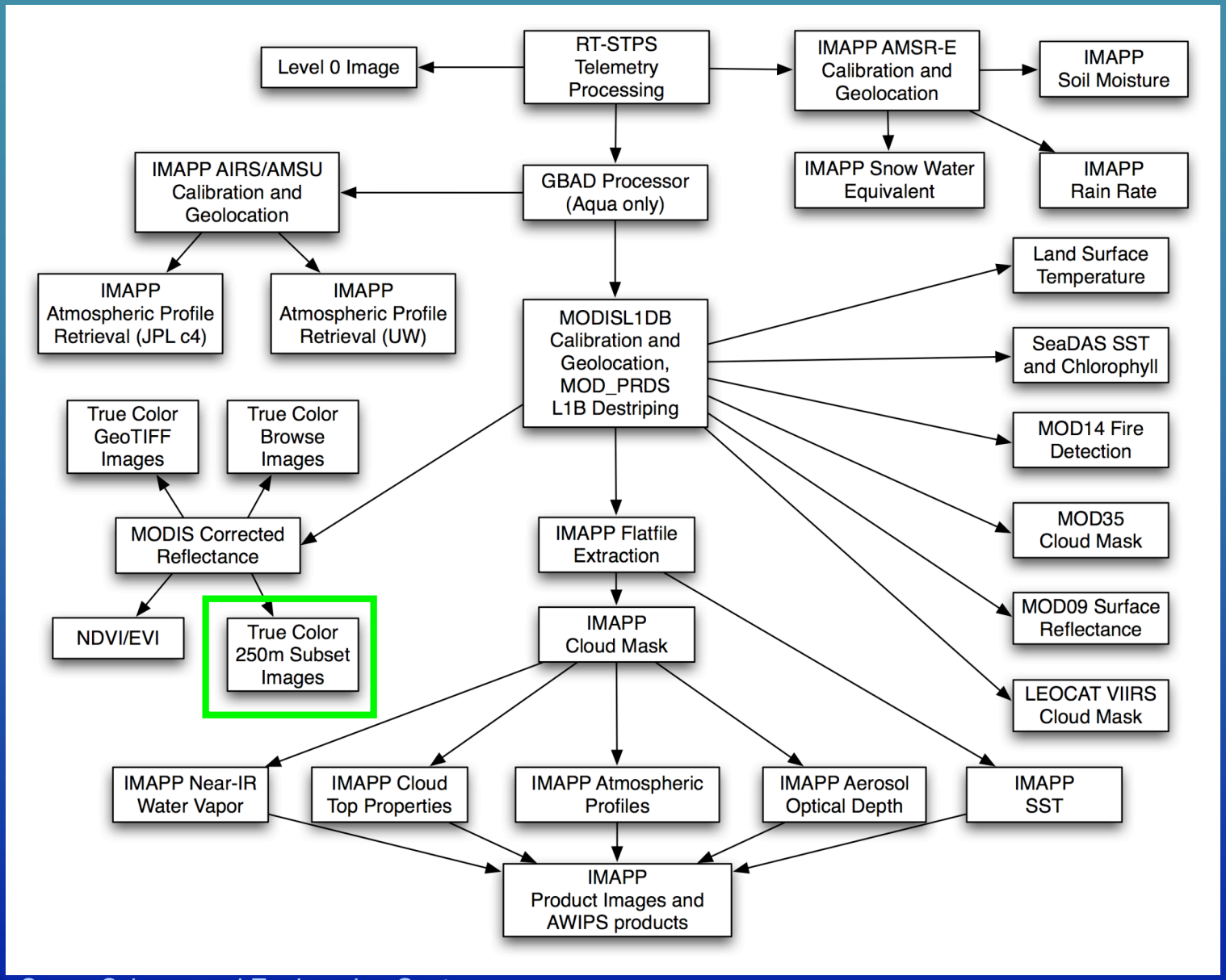
NSIDC: MS2GT

JPL/RSS/UW: IMAPP MODIS L2, IMAPP AIRS L1/L2, IMAPP AMSR-E L1/L2

UW: McIDAS-Lite, McIDAS, ADDE, MODDS, MOD35

ITTVIS: IDL

SSEC DB Processing System: Data Flow



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"MODIS Today" Design

Goals

1. Provide real-time images from MODIS over the continental United States at up to 250 meter resolution
2. Web based format, quick to load and easy to browse
3. Provide continuously updating images in Google Earth

Constraints

1. USA at 250 meter resolution is 20800 x 12000 pixels (250 Megapixels)
2. Cannot cover entire USA with just one DB station

California fires 2007/10/23
MODIS image in Google Earth

MODIS Today: Data Reception Sites

Oregon State University

THE UNIVERSITY of WISCONSIN MADISON

NASA

Space Science and Engineering Center
University of Wisconsin-Madison

USA Subset Regions: 8 equally sized images

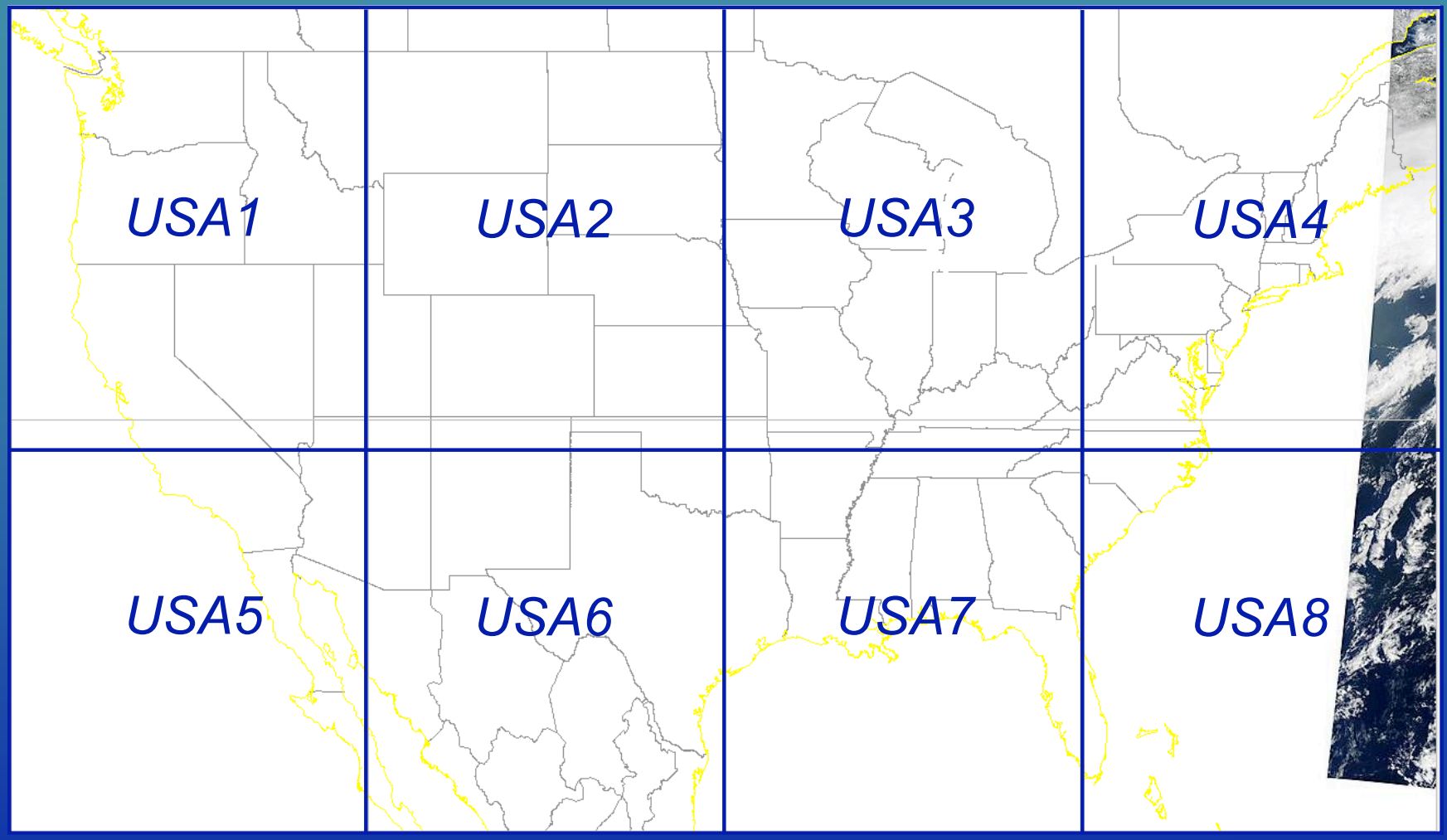

Plate Carrée Projection; 5200 x 6000 pixels each

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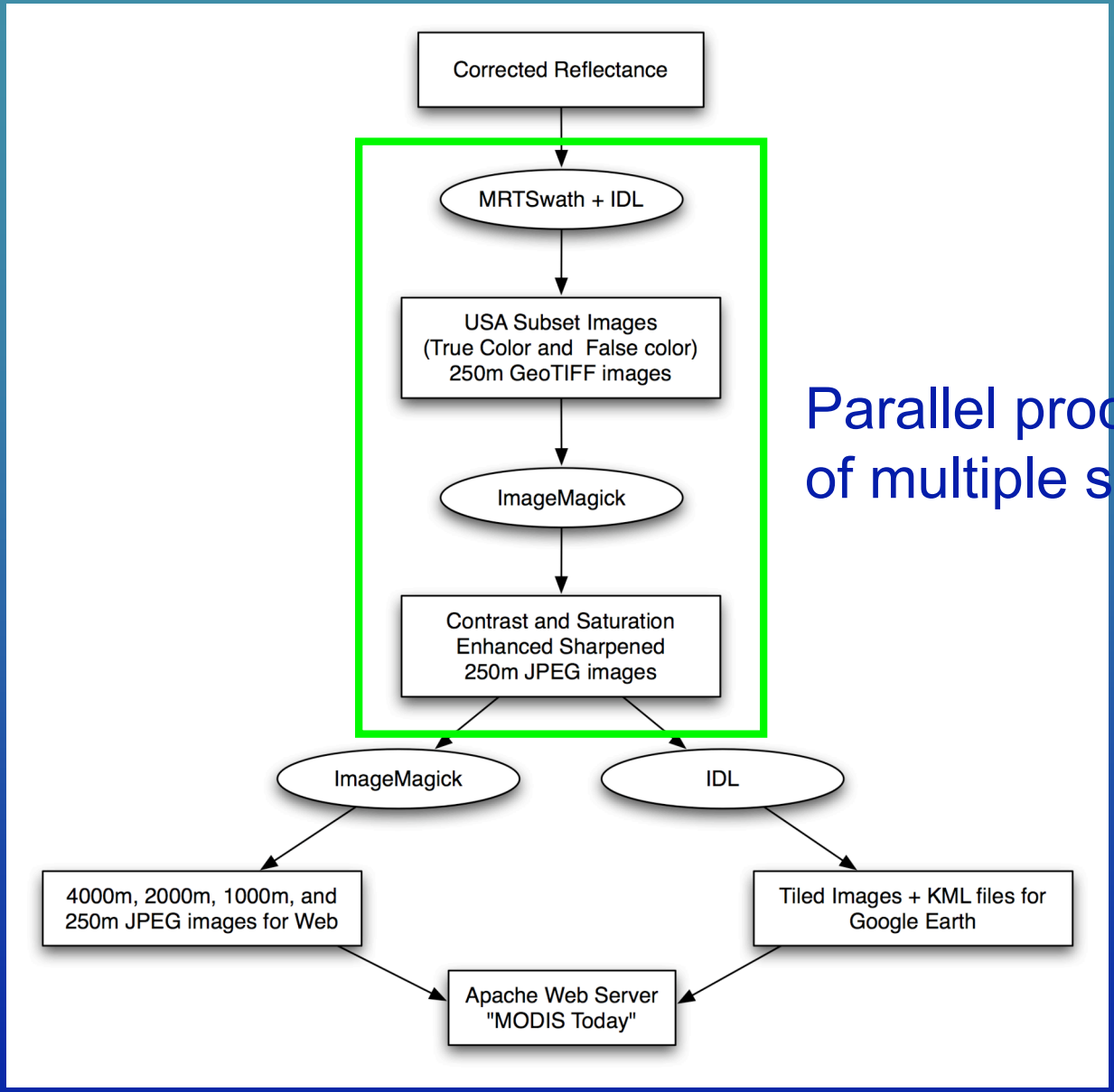
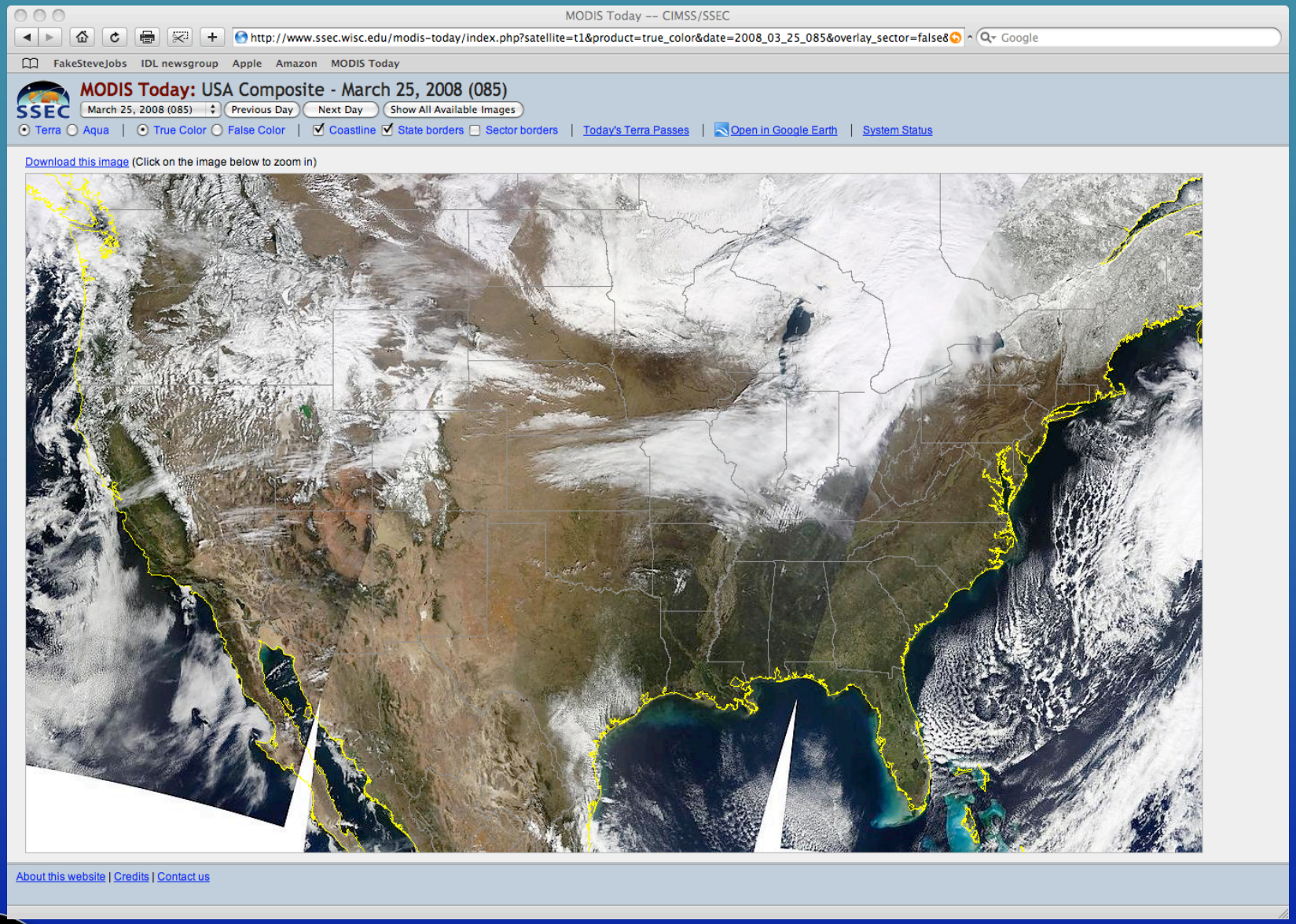
SSEC DB Processing System: True Color Subset Images

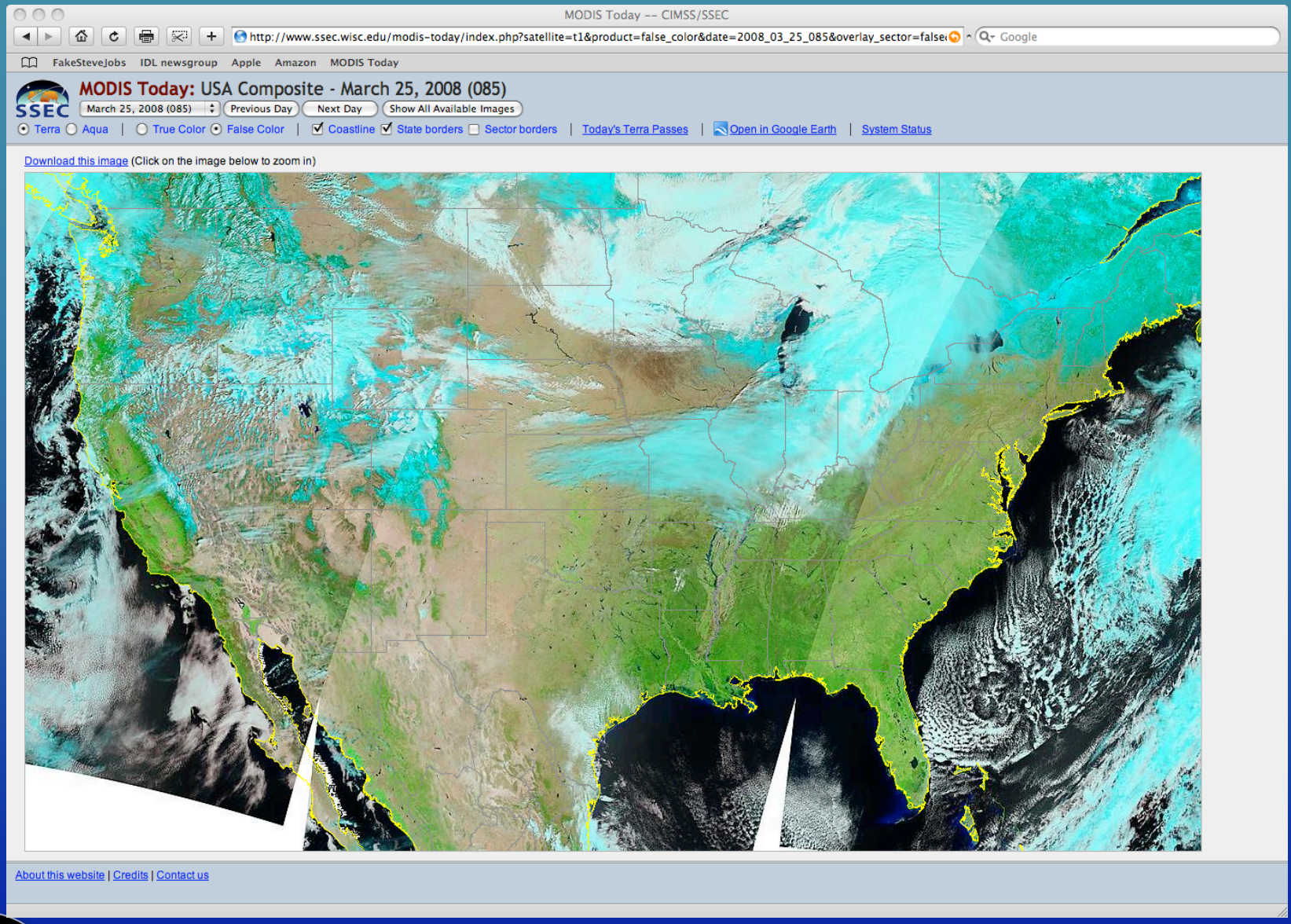


Parallel processing of multiple subsets

MODIS Today: Web View (True Color)



MODIS Today: Web View (False Color)



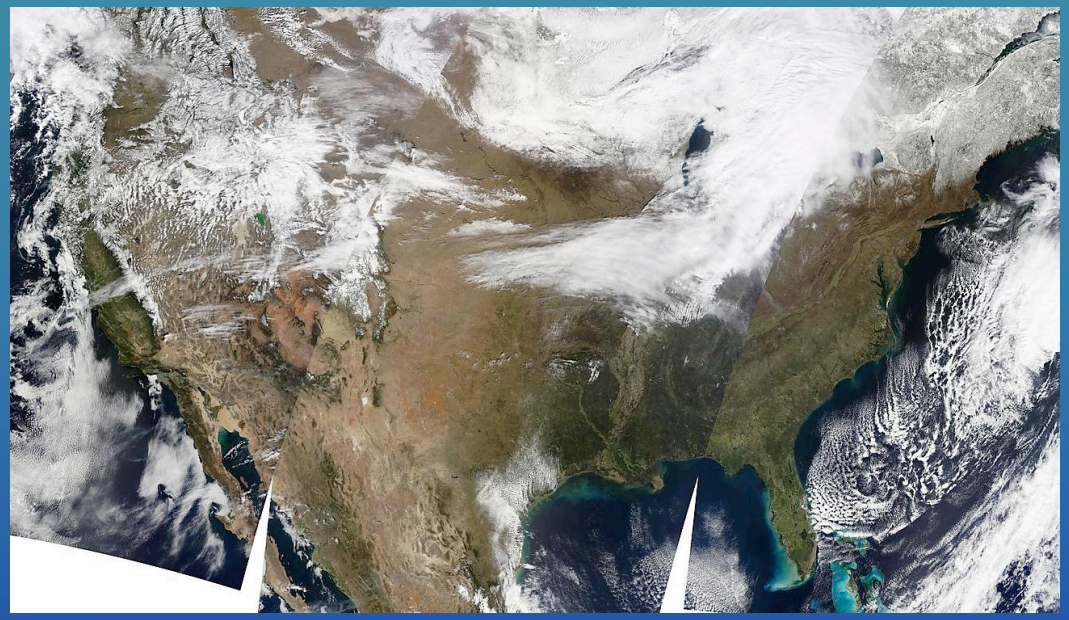
MODIS Today: Web Controls

1. Date Navigation (previous, next, calendar)
2. Satellite (Terra, Aqua)
3. Image type (True Color, False Color)
4. Overlays (Coastline, State borders, Sector borders)
5. Map of today's passes
6. Open in Google Earth (downloads a KML file)

“MODIS Today” real-time imagery in Google Earth

20,800 pixels

12,000 pixels



Total
249,600,000 pixels

USA Composite Imge at 250 meter resolution

Q: How can I share a 250 megapixel image with the world?

A: One piece at a time.

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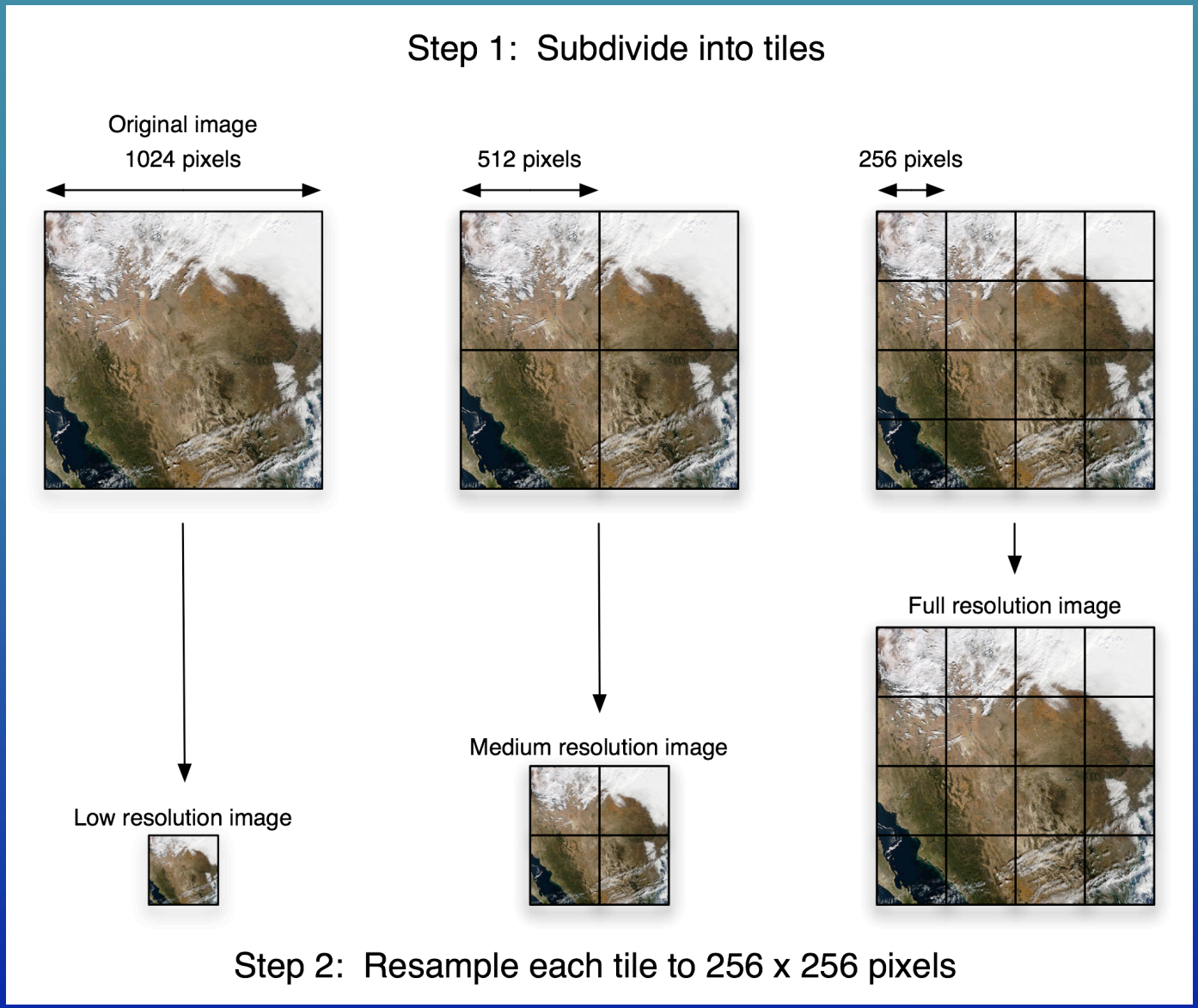
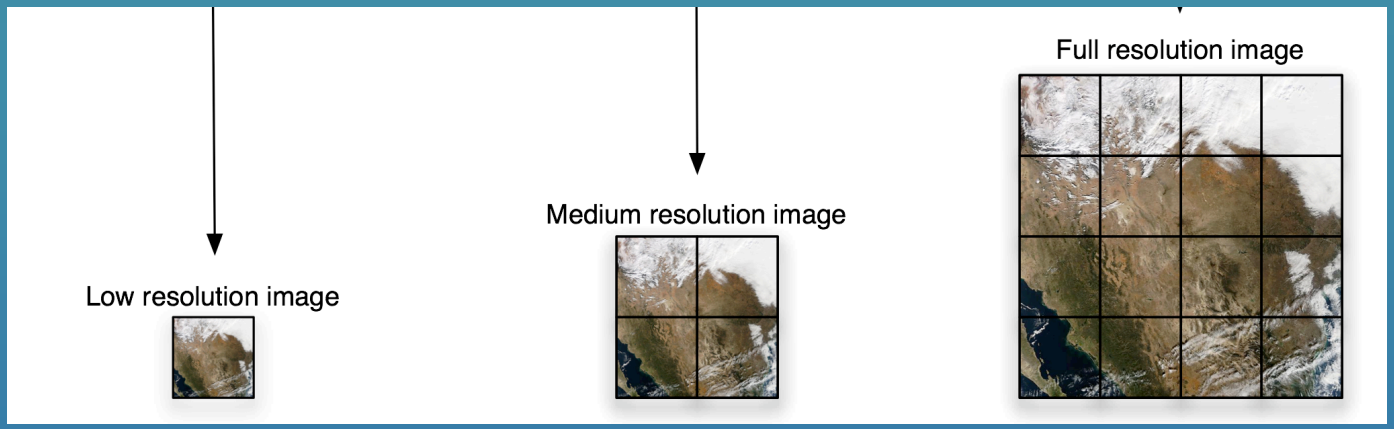
GeoTIFF/JPEG to KML: Image Tiling



Keyhole Markup Language (KML) File Structure

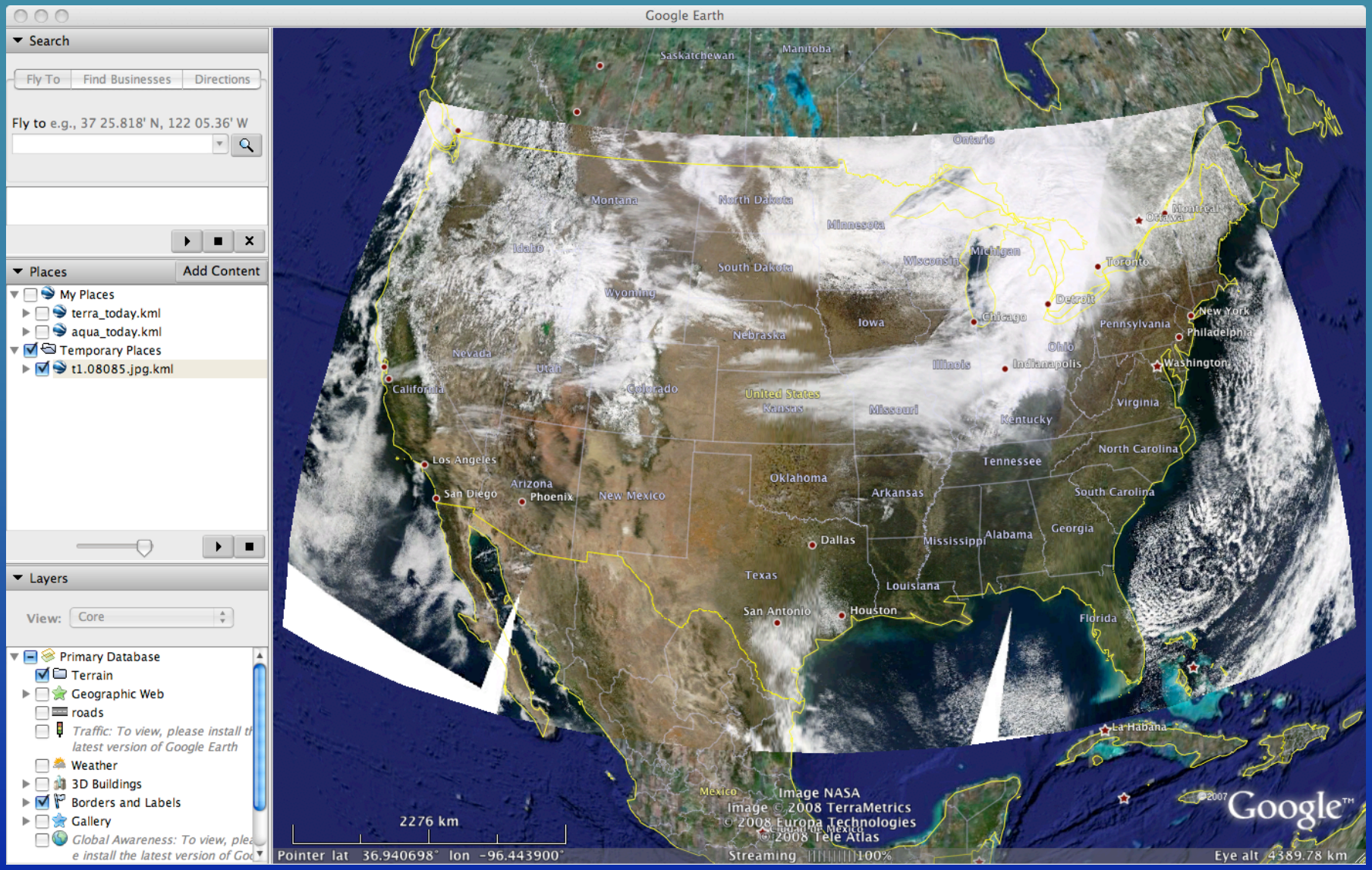


For each tiled image, a KML file contains

1. Region corner coordinates and visibility criteria
2. Network links to the child KML files (tiles in the next level)
3. A network link to the image for this region

KML files and tiled images are created in IDL (runs in about 2 minutes). KML files and JPEG images are sent to SSEC Apache web server. User downloads 1 small KML file.

MODIS Today: Google Earth View



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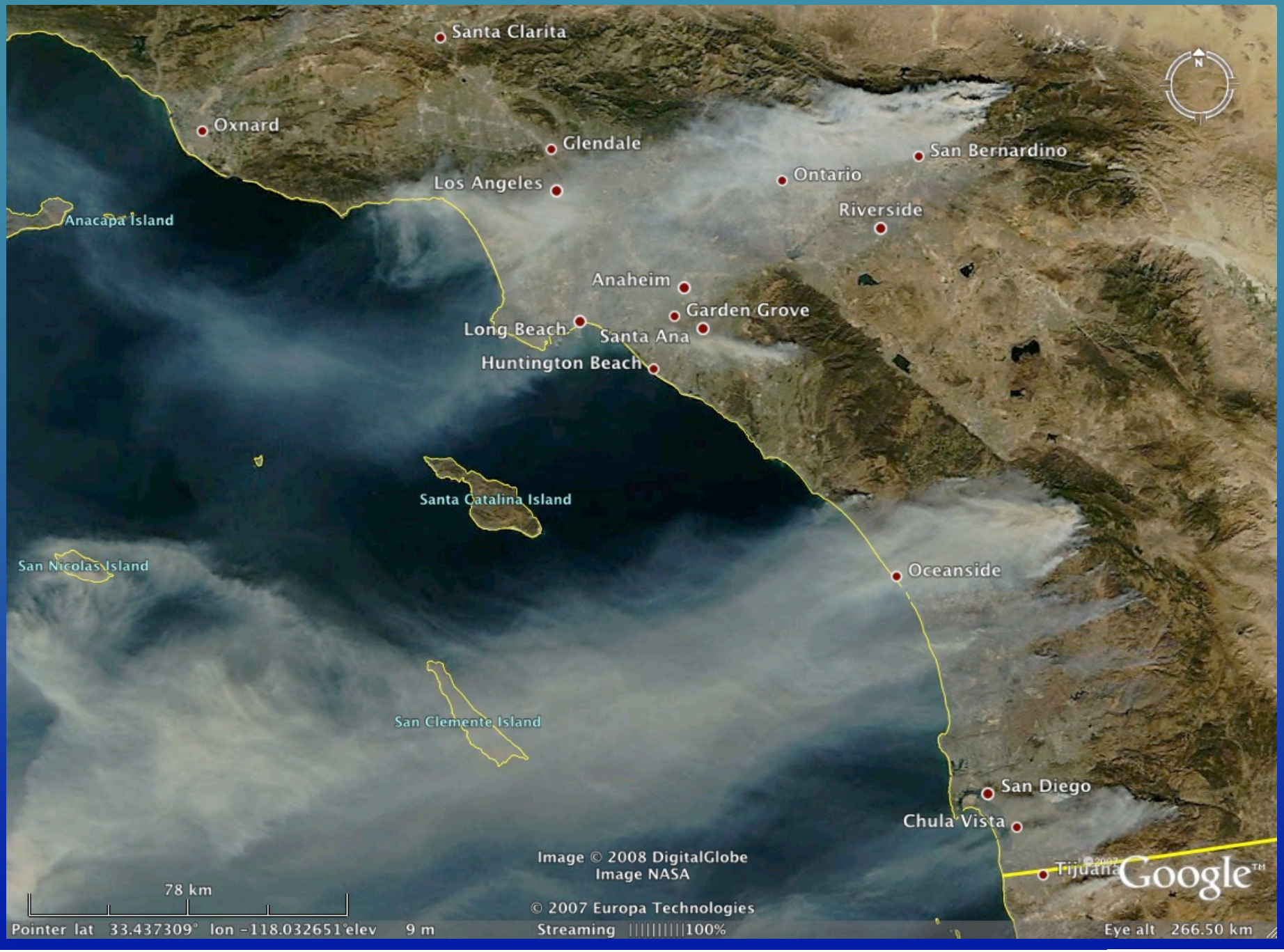
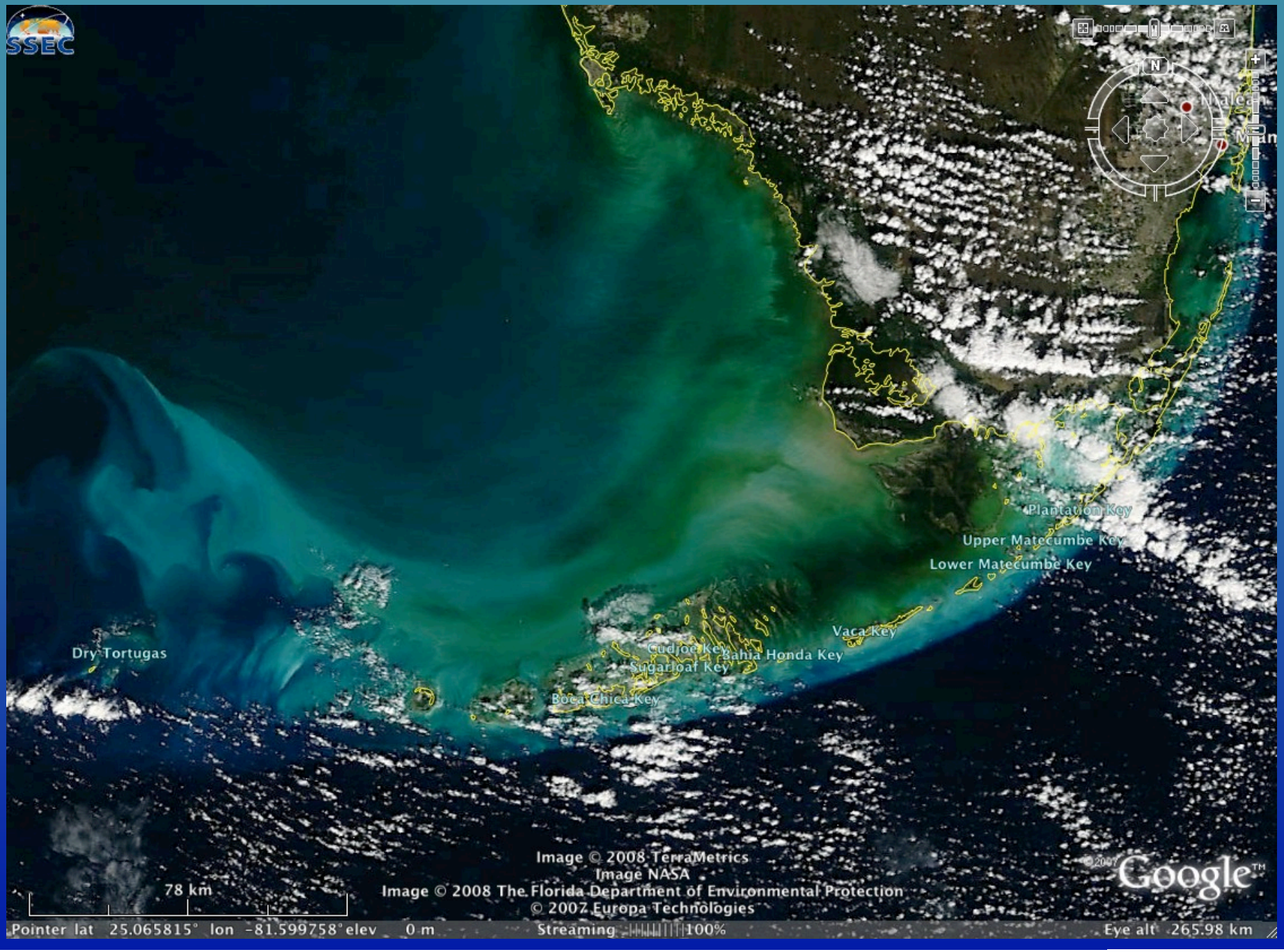
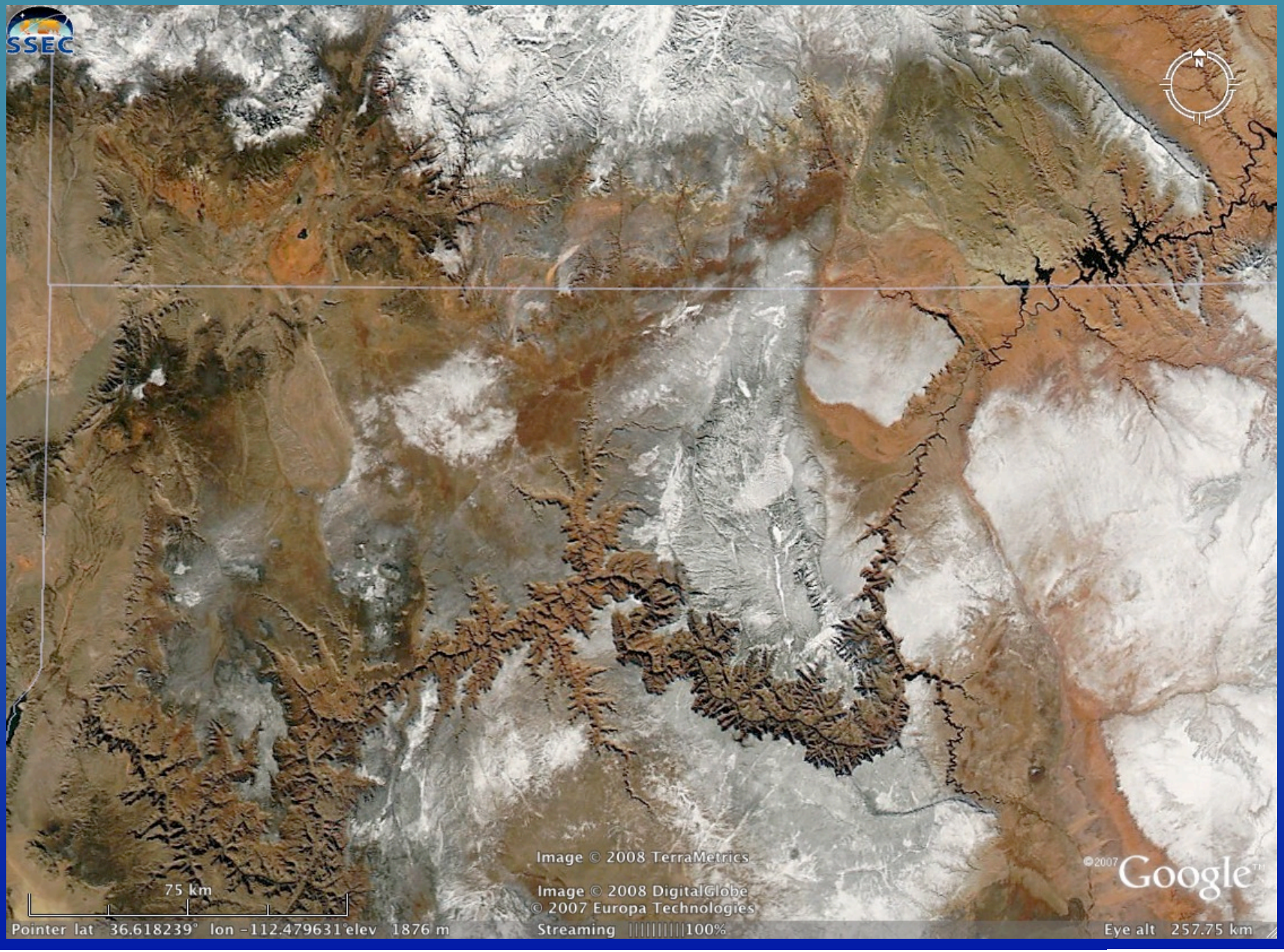
California Fires (Oct. 2007)

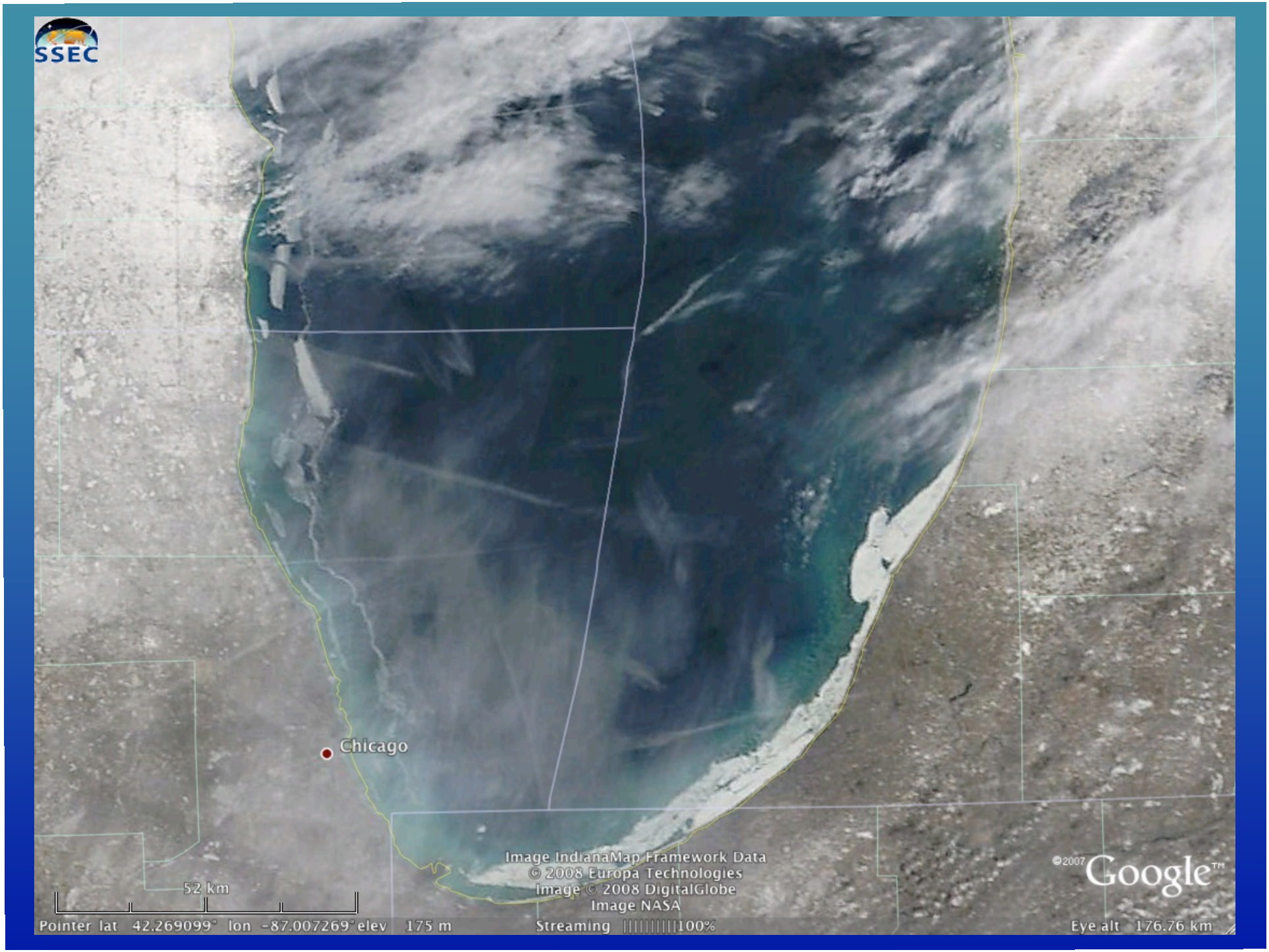


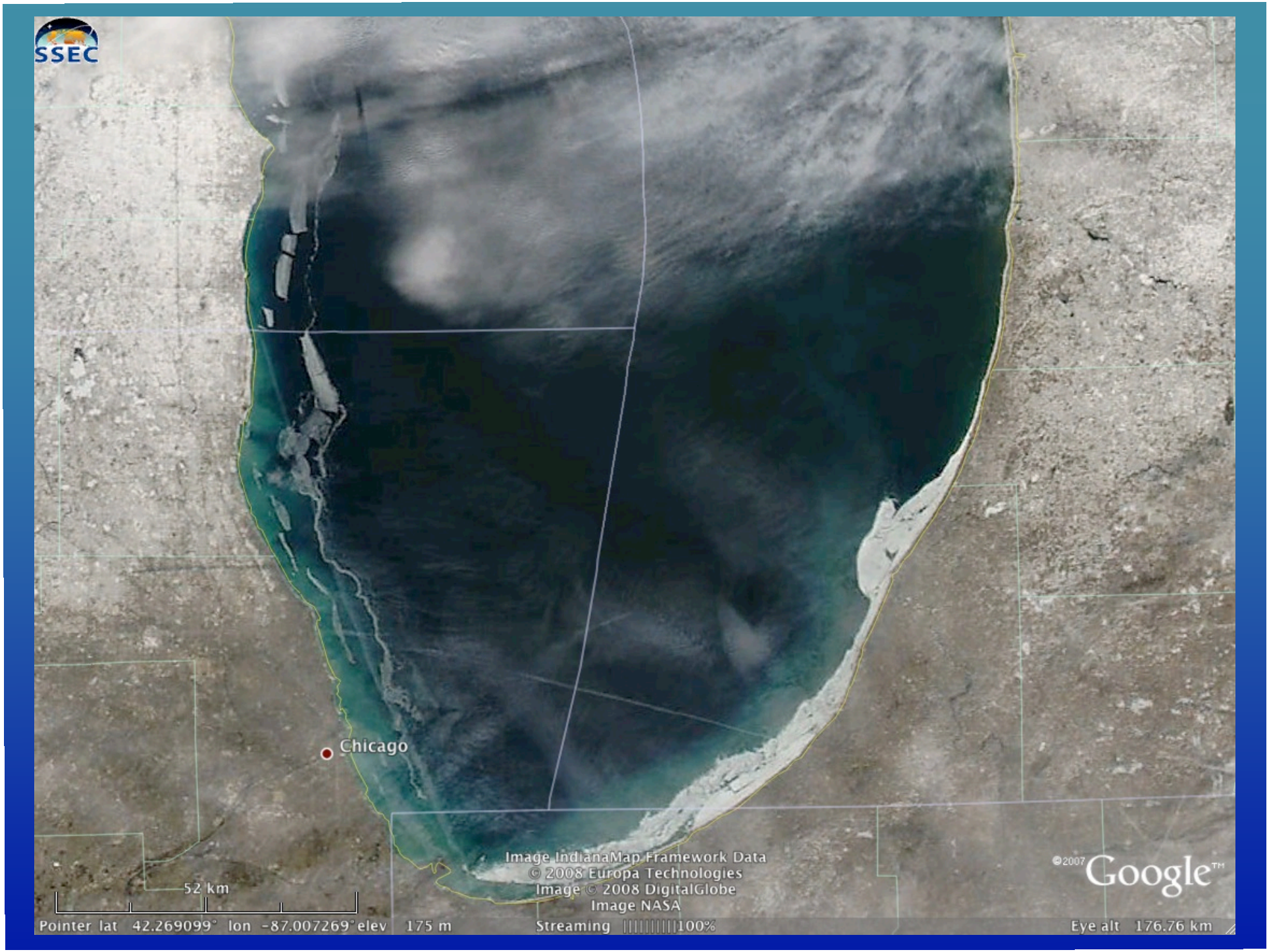
Florida Keys



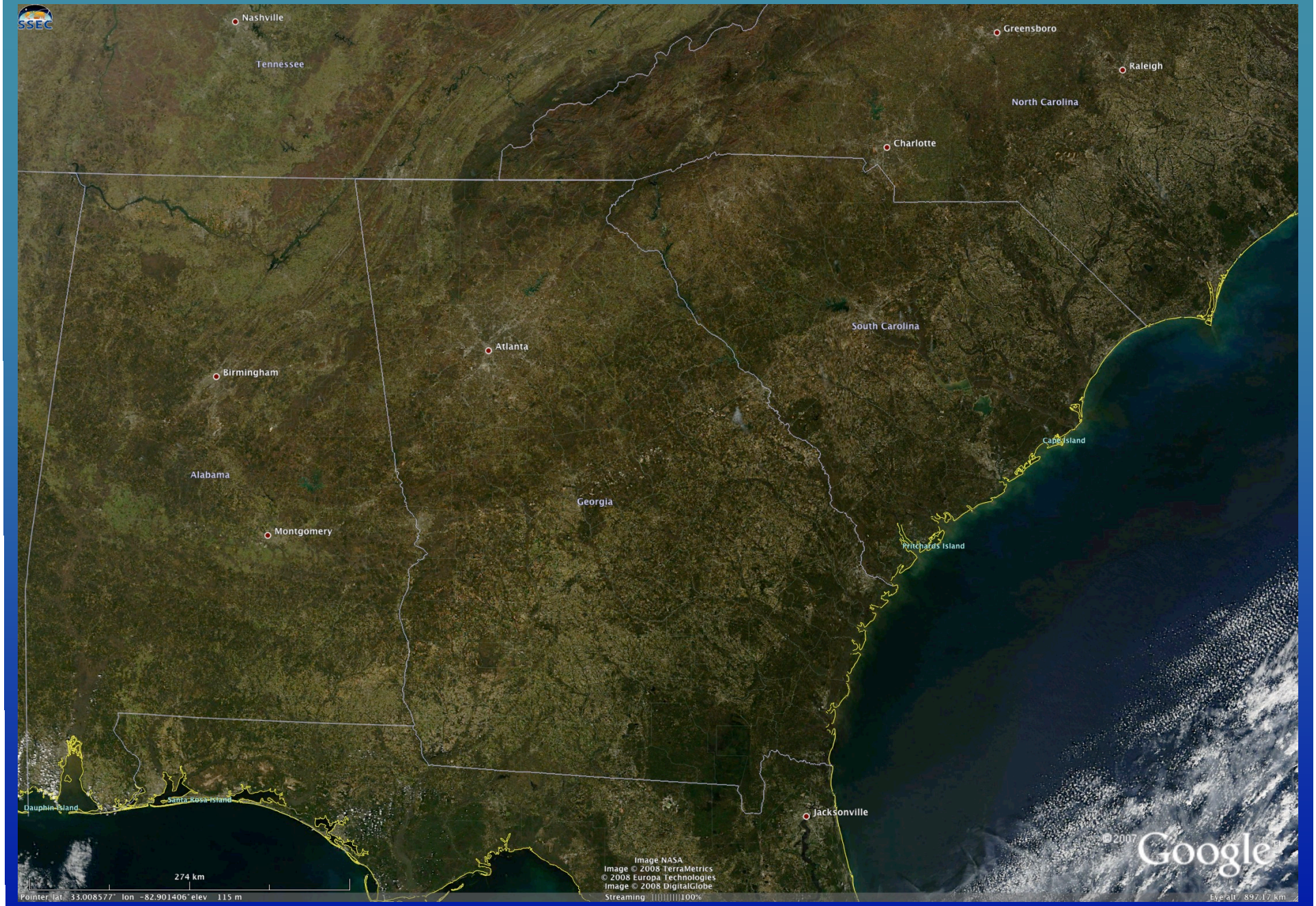
Snow cover in Utah and Arizona




SSEC
Chicago
Image IndianaMap Framework Data
© 2008 Europa Technologies
Image © 2008 DigitalGlobe
Image NASA
©2007 Google™
52 km
Pointer lat 42.269099° lon -87.007269° elev 175 m
Streaming 100%
Eye alt 176.76 km


SSEC
Chicago
Image IndianaMap Framework Data
© 2008 Europa Technologies
Image © 2008 DigitalGlobe
Image NASA
©2007 Google™
52 km
Pointer lat 42.269099° lon -87.007269° elev 175 m
Streaming 100%
Eye alt 176.76 km

Fires in Southeast US 2008/03/12: Morning



Fires in Southeast US 2008/03/12: Afternoon